**ASME BPV II Part B Specification Review Form**

***NOTE: This form is a coversheet that is for information only***

|-----------------|--------------------------------------------------|--------------------------|

**Recommended Subtitle for ASME Specification:**
Identical with Specification ASTM B493/B493M-14 (R19)

**Previous ASTM Version adopted by ASME:** 08e1

**ASTM Revisions reviewed:** 08e1, 14, 14(R19)

### Review Checklist

#### Part I – New Material Addition

Has a new grade, type, or class of material(s) been added to the specification since the last ASME adoption?

- **YES** ☐
- **NO** ☒

If a new grade, type, or class of material(s) has been added, then will the specification adoption result in the need for a revision to either an ASME BPV Code Volume or an ASME Code Case?

- **YES** ☐
- **NO** ☒
- **NA** ☒

Reason for answer:

#### Part II – A Change to an Existing Material

Have any of the following items changed for a material(s) that, as of the last ASME adoption, was already in the ASTM specification:

- A mechanical property?
- **YES** ☐
- **NO** ☒

- A scope or thickness range?
- **YES** ☐
- **NO** ☒

- Any chemical requirements or physical properties?
- **YES** ☐
- **NO** ☒

- A heat treatment temperature or range?
- **YES** ☐
- **NO** ☒

If ANY of the above answers is **YES**, then does the material(s) with the changed property appear in either an ASME BPV Code Volume or an ASME Code Case?

- **YES** ☐
- **NO** ☒
- **NA** ☒

If the material(s) with the changed property appears in an ASME BPV Code Volume(s)/Code Case(s), then will the adoption of this specification result in the need for the Volume/Code Case to be revised?

- **YES** ☐
- **NO** ☒
- **NA** ☒

Reason for answer:

If the adoption of this ASTM specification will result in the need for an ASME BPV Code Volume/Code Case revision, then has the technical basis for the change been attached in the Record’s Background Material tab?

- **YES** ☐
- **NO** ☒
- **NA** ☒

(If **NO**, state why:)

#### Part III – Other Significant Changes / BPV II Table II-200

Did other change(s) occur in the ASTM specification of which ASME BPV II needs to be aware?

- **YES** ☐
- **NO** ☒

Were any changes in the ASTM specification made as a result of an ASME request?

- **YES** ☐
- **NO** ☒

Has any change(s) been made to the ASTM specification that was not already identified in Parts I-II and which is objectionable to ASME?

- **YES** ☐
- **NO** ☒

Will any of the proposed changes make any grade, type, or class of material(s) obsolete?

- **YES** ☐
- **NO** ☒
With this adoption, does Mandatory Appendix II, Table II-200-1 need to restrict the usage of certain versions of this ASTM specification?

Editions before -08 were excluded, i.e. 83 (R93) – 01(2003) because these required that a statement on mandatory certification be included. This then required that Table II-200-1 to be modified to eliminate the statement “For permissible editions prior to 08, identical except that certification is mandatory, for the 08 and later editions, identical” and changed to “Identical”

Part IV – Other ASTM Changes & Recommended ASME Corrections

Other Changes to the ASTM Specification
(since the last ASME Spec Adoption)

Between 08 and 08e1, an editorial correction was made in para 12.1.
Between 08e1 and 14, 1.4 of the Scope was added which dealt with the World Trade Organization and the spec title for ASTM Test Methods was changed from E8 to E8/E8M in sec.12.1

Recommended Corrections for Adoption into ASME BPV II

None

NOTE: The intent is that the ASTM proprietary footnotes and notes be removed and not printed. The editors have historically deleted the "boilerplate" and, in addition, have taken care of additional details such as adding the ASME logo and adding the recommended subtitle shown above.

Respectfully submitted: __Richard Sutherlin________________________ Thursday, June 25, 2020, 9:16 AM
Phone _______ 541-990-6814 __________________ email _rsuther223@comcast.net __________________
SPECIFICATION FOR ZIRCONIUM AND ZIRCONIUM ALLOY FORGINGS

SB-493/SB-493M

(Identical with ASTM Specification SB493/B493M-08e1.)

Identical with Specification ASTM B493/B493M-14 (R19)
1. Scope

1.1 This specification\(^1\) covers three grades of zirconium and zirconium alloy forgings (see 4.1).

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 The following safety hazards caveat pertains only to the test method portion, Section 12, of this specification: This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.4 This International standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:

E8/E8M Test Methods for Tension Testing of Metallic Materials

3. Terminology

3.1 Lot Definition:

3.1.1 forgings, \(n\) —parts, including semi-finished products, or complex shapes, produced by hot mechanical work using hammers, presses, or forging machines; a lot shall consist of a material of the same size, shape, condition, and finish produced from the same ingot or powder blend by the same reduction schedule and the same heat treatment parameters. Unless otherwise agreed between manufacturer and purchaser, a lot shall be limited to the product of an 8-h period for final continuous anneal, or to a single furnace load for final batch anneal.

4. Classification

4.1 The forgings are furnished in three grades as follows:

4.1.1 Grade R60702—Unalloyed zirconium.

4.1.2 Grade R60704—Zirconium-tin alloy.

4.1.3 Grade R60705—Zirconium-niobium alloy.

5. Ordering Information

5.1 Orders for material under this specification shall include the following information:

5.1.1 Quantity (weight and number of pieces).

5.1.2 Name of material (zirconium forgings),

5.1.3 Finish (Section 9),

5.1.4 Dimension (diameter, thickness, length, width, or as specified in appropriate drawings),

5.1.5 ASTM designation and year of issue,

5.1.6 Grade number (see 4.1), and

5.1.7 Additions to the specification and supplementary requirements, if required, including, but not limited to: product marking (see 17.1), check analysis (see 7.3), inspection (see 13.1), lot definition (see 3.1.1), internal soundness (see 8.1), and surface quality (see 8.2.1) requirements.

Note 1—A typical ordering description is as follows: 8000-lb zirconium forgings, mechanically descaled, 100 mm by 120 mm by 1.2 m rectangular bar, ASTM B493/B493M—08, Grade R60702.

6. Materials and Manufacture

6.1 The forgings shall be formed with conventional forging equipment normally found in primary ferrous and nonferrous metal plants.

6.2 Forgings shall be furnished in the annealed conditions.

7. Chemical Composition

7.1 The material shall conform to the requirements as to chemical composition prescribed in Table 1.
TABLE 1 Chemical Requirements

<table>
<thead>
<tr>
<th>Element</th>
<th>Composition, %</th>
<th>UNS Grade Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R60702</td>
<td>R60704</td>
</tr>
<tr>
<td>Zirconium + hafnium, min(^a)</td>
<td>99.2</td>
<td>97.5</td>
</tr>
<tr>
<td>Hafnium, max</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Iron + chromium</td>
<td>0.2 max</td>
<td>0.2 to 0.4</td>
</tr>
<tr>
<td>Tin</td>
<td>...</td>
<td>1.0 to 2.0</td>
</tr>
<tr>
<td>Hydrogen, max</td>
<td>0.005</td>
<td>0.005</td>
</tr>
<tr>
<td>Nitrogen, max</td>
<td>0.025</td>
<td>0.025</td>
</tr>
<tr>
<td>Carbon, max</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Niobium</td>
<td>...</td>
<td>2.0 to 3.0</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.16</td>
<td>0.18</td>
</tr>
</tbody>
</table>

\(^a\)By agreement between the purchaser and the manufacturer, analysis may be required and limits established for elements and compounds not specified in the table of chemical composition.

\(^b\)Zirconium is determined by difference.

TABLE 2 Permissible Variation in Check Analysis Between Different Laboratories

<table>
<thead>
<tr>
<th>Element</th>
<th>Permissible Variation in Product Analysis, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>0.002</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.01</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.01</td>
</tr>
<tr>
<td>Hafnium</td>
<td>0.1</td>
</tr>
<tr>
<td>Iron + chromium</td>
<td>0.025</td>
</tr>
<tr>
<td>Tin</td>
<td>0.05</td>
</tr>
<tr>
<td>Niobium</td>
<td>0.05</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.02</td>
</tr>
</tbody>
</table>

7.2 The manufacturer’s ingot analysis shall be considered the chemical analysis for forgings, except for hydrogen and nitrogen, which shall be determined on the finished product.

7.3 When requested by the purchaser and stated in the purchase order, a check analysis for any elements listed in Table 1 shall be made on the finished product.

7.3.1 The manufacturer’s analysis shall be considered as verified if the check analysis confirms the manufacturer’s reported values within the tolerances prescribed in Table 2.

8. Workmanship and Quality Level Requirements

8.1 The material shall be free of injurious imperfections. Minor surface imperfections may be removed by spot grinding if such grinding does not reduce the dimensions of the finished piece below the minimum permitted by the tolerance for the product.

9. Finish and Appearance

9.1 The forgings shall have one of the following surface conditions as specified in the purchase order:

9.1.1 As forged,
9.1.2 Mechanically descaled, or
9.1.3 Mechanically descaled and pickled.

10. Tensile Requirements

10.1 The material, as represented by the test specimens, shall conform to the tensile properties prescribed in Table 3.

11. Number of Tests and Retests

11.1 Two tension tests shall be performed on each lot.

11.2 Two chemistry tests for hydrogen and nitrogen content shall be performed on each lot of finished product.

11.3 Retests:

11.3.1 If any sample or specimen exhibits obvious surface contamination or improper preparation disqualifying it as a truly representative sample, it shall be discarded and a new sample or specimen substituted.

11.3.2 If the results of any tests of any lot do not conform to the requirements specified, retests shall be made on additional forgings of double the original number from the same lot, each of which shall conform to the requirements specified.

12. Test Methods

12.1 Tension Tests—Tension tests shall be performed in accordance with Test Methods E8/E8M. Determine the yield strength by the offset (0.2 %) method. Determine the tensile properties using a strain rate of 0.003 to 0.007 mm/mm/min [in./in./min] through the yield strength. After the yield strength has been exceeded, increase the cross-head speed to approximately 0.05 mm/mm/min [in./in./min] to failure.

12.2 Chemical Tests—The chemical analyses shall be performed according to the standard techniques normally used by the manufacturer.

13. Inspection

13.1 The manufacturer shall inspect the material covered by this specification prior to shipment. If so specified in the purchase order, the purchaser or his representative may witness the testing and inspection of the material at the place of manufacture. In such cases, the purchaser shall state in his purchase order which tests he desires to witness. The manufacturer shall give ample notice to the purchaser as to the time and place of the designated tests. If the purchaser’s representative does not present himself at the time agreed upon for the testing, the manufacturer shall consider the requirement for the purchaser’s inspection at the place of manufacture to be waived.

13.2 The manufacturer shall afford the inspector representing the purchaser, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. This inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

14. Rejection and Rehearing

14.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of
dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

15. Certification

15.1 A producer’s or supplier’s certification shall be furnished to the purchaser certifying that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. A report of the test results shall be included as part of the certification.

16. Referee

16.1 In the event of disagreement between the manufacturer and the purchaser on the conformance of the material to the requirements of this specification or any special test specified by the purchaser, a mutually acceptable referee shall perform the tests in question. The results of the referee’s testing shall be used in determining conformance of the material to this specification.

S1. Special Internal Soundness

S1.1 Forging shall be produced with specified internal soundness to be verified by electric test or radiography to standards agreed upon between the manufacturer and the purchaser prior to the acceptance of the order.

SUPPLEMENTARY REQUIREMENTS

S2. Surface Quality

S2.1 The surface quality shall be as agreed upon between the manufacturer and the purchaser.

17. Product Marking

17.1 Unless otherwise specified, each forging over 1 kg [2 lb], manufactured in accordance with this specification, shall be marked legibly, either by stenciling, stamping, or rolling with the manufacturer’s private identification mark, the ASTM designation, the grade, and lot number. On smaller than 1 kg [2 lb] forgings, the same information shall be stamped legibly on the container, or on a metal tag securely fastened to each part or package of parts.

18. Packaging and Package Marking

18.1 The forgings shall be packaged either in a suitable box or banded on a skid.

19. Keywords

19.1 zirconium; zirconium alloy forging

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<table>
<thead>
<tr>
<th>Specification</th>
<th>Latest Adopted ASTM</th>
<th>Description</th>
<th>Other Acceptable ASTM Editions</th>
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<tbody>
<tr>
<td>SB-408</td>
<td>06(R11)</td>
<td>Identical except that certification and a test report have been made mandatory.</td>
<td>87 through 06(R11)</td>
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<tr>
<td>SB-409</td>
<td>06(R11)</td>
<td>Identical except that certification and a test report have been made mandatory.</td>
<td>87 through 06(R11)</td>
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<tr>
<td>SB-423</td>
<td>05(R09)</td>
<td>Identical except that certification is mandatory, 4.1.8 has been changed to reference 9.1, and an editorial correction to X1.1.</td>
<td>84 &amp; through 05(R09)</td>
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<td>SB-424</td>
<td>11</td>
<td>Identical except that certification has been made mandatory and a report of test results shall be furnished.</td>
<td>87 through 11</td>
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<td>SB-425</td>
<td>99(R09)</td>
<td>Identical except that certification has been made mandatory.</td>
<td>84 through 99(R09)</td>
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<tr>
<td>SB-434</td>
<td>06(R11)</td>
<td>Identical except that certification and test reports have been made mandatory.</td>
<td>83a through 06(R11)</td>
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<td>SB-435</td>
<td>06(R16)</td>
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<td>87a through 06(R16)</td>
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<td>SB-443</td>
<td>00(R14)</td>
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<td>84 through 00(R14)</td>
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<td>SB-444</td>
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<td>84 through 06(R11)</td>
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<td>SB-446</td>
<td>03(R08)</td>
<td>Identical except that certification and reporting have been made mandatory, and lot definition is revised.</td>
<td>84 through 03(R08) &amp;</td>
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<tr>
<td>SB-462</td>
<td>10</td>
<td>Identical except that certification and a test report have been made mandatory, and chemistries of 06686 and 08031 were corrected in Table 1. Acceptable ASTM editions are limited to 06 and later for N06200 material, and exclude 10 for N06222 material, and exclude 10e1 for N06686 and 08031 material.</td>
<td>82 through 10 &amp;</td>
</tr>
<tr>
<td>SB-463</td>
<td>04(R09)</td>
<td>Identical except that certification and reporting have been made mandatory.</td>
<td>84 through 04(R09)</td>
</tr>
<tr>
<td>SB-464</td>
<td>05(R09)</td>
<td>Identical except that certification has been made mandatory.</td>
<td>84 through 05(R09)</td>
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<td>SB-466/SB-466M</td>
<td>14</td>
<td>Identical except for the deletion of paras. 5.2.1, 9.5, and 9.5.1 to make tensile testing mandatory for all sizes. Certification and test reports have been made mandatory.</td>
<td>92a through 14</td>
</tr>
<tr>
<td>SB-467</td>
<td>14</td>
<td>Identical except that the use of filler metal is prohibited. Certification, test report, and product specification marking have been made mandatory.</td>
<td>88(R03) through 14</td>
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<tr>
<td>SB-468</td>
<td>04(R09)</td>
<td>Identical except that certification has been made mandatory.</td>
<td>84 through 04(R09)</td>
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<tr>
<td>SB-473</td>
<td>07(R13)</td>
<td>Identical except certification is mandatory.</td>
<td>87 through 07(R13)</td>
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<td>SB-493/SB-493M</td>
<td>08</td>
<td>Identical except that certification is mandatory, for the 08 and later editions.</td>
<td>82(R02) through 08 &amp;</td>
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<td>15</td>
<td>Identical except that certification and test reports have been made mandatory, UNS Numbers corrected for Grades M35-2, N3M, and N7M in Table 1, and E1473 replaces E30, E38, and E76 in paras. 2.1 and 7.4.</td>
<td>86 through 15</td>
</tr>
<tr>
<td>SB-505/SB-505M</td>
<td>08a</td>
<td>Identical except that certification, marking, test reports, and conformance to mechanical properties have been made mandatory.</td>
<td>87 through 08a</td>
</tr>
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<td>SB-511</td>
<td>01(R09)</td>
<td>Identical except that certification has been made mandatory.</td>
<td>87 through 01(R09)</td>
</tr>
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<td>SB-514</td>
<td>05(R14)</td>
<td>Identical except that certification has been made mandatory.</td>
<td>85 through 05(R14)</td>
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